

International Journal of Agriculture Extension and Social Development

Volume 7; Issue 10; October 2024; Page No. 221-228

Received: 18-07-2024
Accepted: 24-08-2024

Indexed Journal
Peer Reviewed JOURNAL

Development of a scale to measure the adaptability of farmers to climate change

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DOI: <https://doi.org/10.33545/26180723.2024.v7.i10d.1213>

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Abstract

Climate change is a critical challenge for the agricultural sector, particularly in developing countries like India, where agriculture is highly sensitive to shifts in climate patterns. The ability of farmers to adapt to climate change is essential for maintaining agricultural productivity and ensuring food security. This study aimed to construct a scale to measure the adaptability of farmers to climate change, with a focus on the Saurashtra region of Gujarat. Adaptability is conceptualized as the capacity of farmers to adjust their practices, both traditional and modern, to mitigate the adverse effects of climate change. Using the Likert summated ratings method, a comprehensive scale was developed through a systematic process of item collection, editing, and validation. Initially, 85 statements were collected from various sources, including literature and expert consultations. These were refined to 70 based on clarity and relevance, and further scrutinized by a panel of experts from agricultural universities and extension institutes. The final selection process, based on criteria such as relevancy percentage, mean relevancy weightage, and item analysis, resulted in 25 statements with high discriminative values. The scale was standardized by assessing its validity and reliability. Content validity was ensured through expert input, while reliability was tested using the split-half method, resulting in a reliability coefficient of 0.73, indicating high reliability. The final scale consists of 25 statements, grouped into six sub-dimensions: crop production, livestock production, economic aspects, communication behavior, resource availability, and innovative behavior. This scale provides a valuable tool for assessing farmers' adaptability to climate change, which is critical for developing targeted interventions and policies aimed at enhancing resilience in the agricultural sector. By understanding farmers' perceptions and adaptive capacities, stakeholders can better address the challenges posed by climate change and promote sustainable agricultural practices.

Keywords: Climate change, scale, adaptability, reliability, validity, Likert summated ratings

Introduction

Various studies and reports have suggested India to be one of the most vulnerable developing nations towards climate change (IPCC, 2014; Praveen and Sharma, 2020) ^[9, 15]. Climate change, like any other change, is a continuous process, the intensity of which has been anticipated to be increased in future. Several researchers like Dorward *et al.* (2020) ^[5] and Khanal *et al.* (2018) ^[11] have proposed that adaptation to climate change can be a critical policy option to fight the changing climate. It means that we have to increase our adaptability by undertaking adaptation strategies. Changing climatic conditions can have the big effect on our life and our environment. In fact, it is the greatest environmental threat faced by the planet earth (Fazely *et al.*, 2024) ^[8]. Agriculture is one sector which is very sensitive to climate. Any alterations in the climate pattern variates the activities to be undertaken and might also affect the yields. Major climate change indicators such as rainfall, temperature, etc. can significantly affect crop production and yield (Pokiya *et al.*, 2024) ^[14]. Also, the incidence of pests like insects, weeds, micro-organisms *etc.*

has also been reported to be increased. It was observed, for example, in Directorate of Wheat Research, Jabalpur, that the growth and incidence of two weeds in rice crop *viz.* *Echinochloa colona* and *Altemanthera paronychioides* apparently increased and the efficacy of herbicides *viz.* Bispyribac sodium against *E. Colona* and 2,4-D against *A. Paronychioides* got significantly reduced under elevated CO₂. Similarly, in wheat, the bio-efficacy of herbicides like Carfentrazole-ethyl against *Chenopodium album* and *Rumex dentatus* got reduced under elevated CO₂ (ICAR, 2023). So, farmers in particular have to be very adaptive in combating climate change. To address these issues, ICAR has launched National Innovations on Climate Resilient Agriculture (NICRA) project in 100 vulnerable districts across the country to enhance climate resilient agriculture through strategic research and technology demonstrations which covers agriculture and horticultural crops, livestock - fisheries, and efficient management of natural resources (Thakor and Joshi, 2024) ^[18]. But we have faced a public denial to this problem of climate change which has been attributed to lack of awareness among masses, and

scepticism about climate risks and uncertainties is to be determined by environmental and mass media messages (Whitmarsh, 2011)^[19].

In the agricultural context, studies on the perception of farmers on climate change have shown that farmers in Rajasthan believed that climate change was real and the main causes behind this was industrialization, deforestation and heavy uses of fossil fuels (Bishnoi, 2013)^[4]. According to Rathava *et al.* (2023)^[16], the farmers in the North Gujarat region had medium to high level of fair perception about climate change which meant that they perceived climate change to be a real issue of concern. It is obvious that we cannot think of coping climate change unless the farmers perceive it in a real manner and get aware of the issue. Only then, they will get adaptive to it as Jha and Gupta (2021)^[10] have also emphasised that the perception of farmers regarding climate change is a prerequisite for assessing their adaptability. The adaptability of farmers is a function of so many factors associated to crop cultivation viz. family size, age, gender, education level, and farm-size and vary at regions and local level (IPCC, 2014; Opiyo, 2015)^[9, 13]. Farmer Producers Organizations are also helpful in fighting and getting adapted to climate change (Singh *et al.*, 2019)^[17].

Climate change is perceived as the leading challenge by the science fraternity especially with respect to agricultural sector ultimately intimidating global food security and it is imperative to generate assets that mitigate the deadly impact of climate change. Another thing that becomes important is how aware and adaptive are farmers and how well do they understand the intensity of the problem. Under the current situation of climate change, there is a need to adapt risk management strategies that could help farm households enhance their productivity and livelihood security (Ansari, 2023)^[2]. This paper deals with construction of a scale to measure the adaptability of the farmers to climate change. Adaptability has been conceptualised as the ability of the farmers to adapt themselves or mould themselves against the adverse effects of climate change by adopting certain practices which may include traditional as well as modern ones. It can be understood as a counter to the vulnerability. The development of scale required the following procedure to be followed and the obtained results have been discussed in the upcoming sections.

Methodology

In social sciences, there is a number of techniques to develop a scale in order to measure any socio-psychological or behavioural constructs. As social science mainly deals with the behaviour of an individual, the resultant measurements are a consequence of the perceived notions of the individual as in they cannot be termed as concrete. This study focuses on the use of scaling technique developed by Likert (1932)^[12] and Edwards (1957)^[6-7], known as the method of summated ratings. In this method, the scale consists of a set of statements, all of which are considered of holding approximately equal value, and the subjects respond to each of which, with degrees of agreement or disagreement carrying different scores. This method was employed in the study to avoid representing a concept with a single statement. Instead, multiple statements were used as indicators, each reflecting different dimensions of the

concept, to provide a more comprehensive perspective.

2.1 Steps followed in the construction of the scale to measure the adaptability of the farmers

The following steps were followed to develop this scale:

- i) **Items collection:** A set of items and statements regarding the adaptability of the farmers associated with climate change was gathered from available literature in books, journals, magazines, newspapers, and the internet. A tentative list of 85 statements was prepared after researchers consulted with extension experts and farmers.
- ii) **Editing the statements:** The items and statements were meticulously edited according to the fourteen criteria established by Likert (1932)^[12], as well as guidelines from Bird, Edwards, and Kilpatrick. From a total of 85 statements, 70 were selected for being clear and non-ambiguous, avoiding any factual content.
- iii) **Relevancy Percentage:** Not all the collected statements were equally relevant in measuring farmers' adaptability to climate change. Therefore, an expert panel scrutinized these statements for relevance and final inclusion in the scale. The panel included scientists and researchers from various State Agricultural Universities (SAUs), State Departments, and Extension Institutes. The statements were sent to 75 judges with instructions to evaluate each for relevance on a 3-point scale: most relevant, relevant, and least relevant. Out of 75 judges, 60 responded within two months. The scores from the responses of these judges were summed to calculate the Relevancy Percentage (RP), Mean Relevancy Weightage (MRW), and Mean Relevancy Score (MRS) for each of the 70 statements using specific formulae:

Relevancy Percentage (RP): It is the number of respondents who scored the statements as "most relevant" and "relevant" which is converted into percentage.

$$RP = \frac{FS}{\text{No. of respondents}} \times 100$$

Where, FS = Frequency score of most relevant and relevant

Mean Relevancy Weightage (MRW): It is the ratio of actual score obtained to the maximum possible score obtainable for each statement. It is calculated by using the following formula:

$$MRW = \frac{MRR \times 3 + RR \times 2 + LRR \times 1}{MPS}$$

Where,

MRR = Most relevant response

RR = Relevant response

LRR = Least relevant response

MPS = Maximum possible score i.e. No. of judges responded X 3 (60 X 3 = 180)

Mean Relevancy Score (MRS): It is the ratio of actual score obtained by each respondent to the number of judges responded for the variable.

$$MRS = \frac{MRR \times 3 + RR \times 2 + LRR \times 1}{No. \text{ of judges}}$$

Where

MRR= Most Relevant Response

RR= Relevant Response

LRR = Least Relevant Response

Using this criterion, the statements were screened for relevancy. Statements with a relevancy percentage above

70%, a mean relevancy weightage above 0.70, and a mean relevancy score above 2 were selected. This process led to the selection and modification of 52 statements, which were rewritten based on the experts' feedback.

The selection of based on the relevancy criteria has been shown in Table 1. Out of 70 statements, 52 statements were selected through this process.

Table 1: Selection of statements based on RP, MRW and MRS as derived from judges' ratings

S. No.	Statements		MRS	MRW	RP
Crop Production					
1.	Undertaking the application of FYM and mulching to avoid soil erosion and evaporation losses from the field		2.51	0.83	98.33
2.	Growing suitable crops under aberrant weather conditions		2.58	0.86	100.00
3.	Undertaking growing drought resistant crops and varieties		2.63	0.87	96.66
4.	Selecting early maturing or late maturing varieties depending upon the weather experience of previous years to escape losses incurred from weather abnormality		2.51	0.83	96.66
5.	Getting adapted to undertaking seed treatment practices		1.83	0.61	66.66
6.	Getting adapted to suitable and timely plant protection measures to avoid crop loss		2.38	0.79	91.66
7.	Practicing crop diversification to mitigate economic losses		2.36	0.78	85.00
8.	Undertaking Integrated Farming System for sustainable farming		2.40	0.80	86.66
9.	Following drainage system to avoid water logging and soil and water erosion		2.41	0.80	95.00
10.	Adopting borewell recharge technology to overcome shortage of water for crop production		2.20	0.73	85.00
11.	Following ridge and furrows system to control soil erosion		2.00	0.66	68.33
12.	Undertaking micro irrigation to overcome shortage of water and prevent water wastage		2.61	0.87	95.00
13.	Adapted to modern methods of agriculture like usage of planters, tillers, zero tillage etc.		2.26	0.75	88.33
14.	Performing subsoiling (once in 4-5 years) to improve water infiltration		2.08	0.69	85.00
15.	Getting adapted to cultivating crops having high water use efficiency like millets, oilseeds and pulses		2.36	0.78	93.33
16.	Getting adapted to the usage of bio-fertilizers and bio-pesticides		2.15	0.71	81.66
17.	Using chemical fertilizers and pesticides at recommended levels at right time		2.30	0.76	95.00
18.	Practicing mulching and inter-cultural operations to avoid weed infestation		2.23	0.74	88.33
19.	Undertaking crop rotation to improve soil fertility		2.51	0.83	96.66
20.	Cultivating catch crops, contingent crops and mixed cropping to avoid economic losses due to unforeseen climatic mishaps.		2.4	0.82	95.00
21.	Following IPM practices including cultural, mechanical, biological and chemical methods		2.48	0.82	95.00
22.	Planting of bund holders and hedge crops to protect crop from evapo-transpiration losses by strong gusty winds.		1.66	0.55	53.33
23.	Planting of trees like Drumsticks, coconut, custard apple, mango etc. on the borders to prevent the fields from winds		2.15	0.71	80.00
24.	Undertaking suitable post-harvest management practices		2.25	0.75	90
25.	Shifting focus to value addition agriculture		2.31	0.77	88.33
	Adapting to contingency cropping plans in case of aberrant weather conditions				
	Rainfall abnormality	Action taken			
26.	Delayed onset of rainfall	Sowing alternate crops of short duration or early maturing varieties of same crop	2.38	0.79	91.66
27.	Early withdrawal of rainfall	Using anti-transpirant sprays, early harvesting at physiological maturity	2.33	0.77	93.33
28.	Intermediary dry spell	Undertaking mulching, thinning, using anti- transpirants	2.15	0.71	85.00
29.	Heavy rainfall	Undertaking practices of water harvesting structures, proper drainage channels, using water-logged resistant varieties	1.93	0.64	68.33
Livestock Production					
30.	Adopting subsidiary activities like animal husbandry, sericulture, apiculture etc. to mitigate any economic losses due to climatic variability		1.95	0.65	66.67
31.	Rearing heat and stress tolerant breeds of animals		1.87	0.62	66.67
32.	Getting adapted to proper hygienic conditions in their sheds to avoid infectious diseases		2.1	0.7	81.66
33.	Following timely vaccinations schedules		2.3	0.76	88.33
34.	Practicing ITK measures to treat diseases in animals		1.76	0.58	55
35.	Growing highly nutritious fodder crops like Napier, Alfalfa to increase strength in animals		1.96	0.65	68.33
36.	Using feed additives to improve milk quality under heat stress conditions		2.28	0.76	90.00
37.	Installing fans and shade nets in sheds to deal with excessive heat in summers		2.28	0.76	93.33
38.	Ensuring proper drinking facilities of animals in excessive heat conditions		2.16	0.72	80.00
39.	Having proper drainage channels to let out water and urine especially in rainy season		1.90	0.63	65.00
Economic aspects					
40.	Having access to credit to meet financial needs in case of any contingency		2.48	0.82	98.33
41.	Having timely access to labour in case of an abnormal weather forecast to hasten harvesting or storage of produce		2.23	0.74	90.00
42.	Adopting proper diversification of household income so as to decrease dependence on only one enterprise		2.15	0.71	88.33

43.	Having access to market and better transportation systems	2.28	0.76	91.66
44.	Having access to and receiving MSP of selected crops	2.01	0.67	71.67
45.	Getting organized in the form of FPOs for collective action	2.20	0.73	85.00
Communication behaviour				
46.	Having access to formal extension advisory services about multi stress resistant varieties	1.95	0.65	70.00
47.	Having access to training regarding disaster management	2.51	0.83	100.00
48.	Having access to Disaster relief assistance	2.23	0.74	88.33
49.	Continuously seeking information from experts regarding climate change and its adverse effects on agriculture	2.36	0.78	95.00
50.	Having access to timely and reliable weather forecast information	1.78	0.59	61.66
Resources available to cope up				
51.	Having sufficiency of farm machinery to meet any kind of contingency	2.21	0.73	93.33
52.	Having good access to agri-inputs	1.68	0.56	58.33
53.	Having good land productivity so that climatic variability can be dealt with ease	1.75	0.58	63.33
54.	Having good livestock productivity to avoid economic losses due to heat stress in animals	2.36	0.78	91.66
55.	Having good productivity from indigenous livestock	2.13	0.71	80.00
56.	Having access and control over ecological assets like water resources, livestock etc.	2.25	0.75	90.00
57.	Adopting the usage of renewable sources of energy like solar, wind etc. for power and irrigation	2.41	0.80	93.33
58.	Having multiplicity of irrigation resources like drip, sprinkler etc.	2.33	0.77	90.00
59.	Having good availability of proper storage facilities	1.93	0.64	70.00
Innovative behaviour				
60.	Developing new ways to cope with water stress, heat waves, cold waves or floods	1.98	0.66	68.33
61.	Using social media to know more about climate change and be ready to adopt measures quickly	2.30	0.76	88.33
62.	Attending seminars, trainings, webinars etc. related to climate change in agriculture	2.25	0.75	86.66
63.	Discussing climate variability with fellow farmers and devising effective strategies to cope up	1.83	0.61	60.00
64.	Adoption of new varieties and hybrid seeds instead of last year's seeds (to avoid inbreeding depression)	2.03	0.67	71.66
65.	Using mobile applications promoted by JAU and ICAR to get updated about climate change and follow recommended practices to cope with it.	2.06	0.68	68.33
Environment				
66.	Motivating fellow farmers to adopt new ways of farming as soon as possible	2.36	0.78	93.33
67.	Constructing reservoirs or structures to collect water in case of floods to reduce flood losses	2.06	0.68	68.33
68.	Constructing ponds for groundwater recharging by accumulating rainwater	2.40	0.80	93.33
69.	Use of plastic pipes for conveying water to avoid seepage loss	1.91	0.63	68.33
70.	Recycling of organic waste/kitchen waste and using it as manure for crops and vegetables	2.35	0.78	96.66

iv) **Item Analysis:** This is a very important step in the Likert technique of scale construction. Item analysis in this context pertains to differentiation between high and low adaptability of the farmers. For this purpose, the schedule consisting of 52 statements was presented to a sample of 30 farmers from non-sampling area as a pilot test. The responses were collected on a five-point continuum viz. Strongly agree, Agree, Undecided, Disagree and Strongly disagree with respective scores as 5,4,3, 2 and 1. All statements had a positive connotation so there was no need of reversing the scores. The adaptability score was calculated by summing up the scores on all statements.

Afterwards, the scores of the farmers were arranged in ascending order. Then, twenty five percent of the respondents with highest scores and twenty percent with the lowest scores were filtered and selected. These two groups were designated as criterion groups for further evaluation of the statements. Thus, out of 30 farmers to whom the items were administered for the item analysis, 8 farmers with highest and 8 with lowest scores were used as a criterion group to evaluate individual item.

Then t-test was followed to determine the extent to which a statement differentiates high group from low group. T value was calculated and then compared with the critical value. The statements having t value greater than critical value were selected. The 't' value was calculated by using the formula suggested by Edwards (1957) [6-7].

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

Where,

$\bar{X}_1$ = the mean score on a given statement for the high group
 $\bar{X}_2$ = the mean score on the same statement for the low group

S_1^2 = the variance of the distribution of responses of high group to the statement

S_2^2 = the variance of the distribution of responses of low group to the statement

n_1 = number of subjects in the high group

n_2 = number of subjects in the low group

The t values of all the selected statements have been shown in Table 2.

v) **Selection of statements for final scale:** After calculating the "t" values for all the items, 25 statements with a "t" value of 1.75 or higher were selected. The guideline of rejecting items with a "t" value below 1.75 was adhered to, as per Edwards (1957) [6-7]. This rule ensured that only items with the highest discriminative values were retained in the scale, while those with poor discriminative ability or questionable validity were eliminated. Consequently, 25 statements were included in the final scale based on the following criteria:

- a) The "t" value must exceed 1.75.
- b) The statement should present a unique idea, without overlapping with other statements.
- c) The statement should be simple and concise.
- vi) **Standardization of the scale:** To standardize the scale, both validity and reliability were assessed.

Validity: The content validity of the scale was evaluated. Content validity refers to the representativeness or adequacy of the content, substance, and topics covered by the measuring instrument. Since the scale comprehensively addressed climate change adaptability in agriculture through a thorough literature review and expert opinions, it was assumed to meet the content validity requirement.

Table 2: Selection of statements based on calculated t values

S. No.	Statements		T value
Crop Production			
1.	Undertaking the application of FYM and mulching to avoid soil erosion and evaporation losses from the field		3.17
2.	Growing suitable crops under aberrant weather conditions		1.09
3.	Undertaking growing drought resistant crops and varieties		4.58
4.	Selecting early maturing or late maturing varieties depending upon the weather experience of previous years to escape losses incurred from weather abnormality		4.00
5.	Getting adapted to suitable and timely plant protection measures to avoid crop loss		1.06
6.	Practicing crop diversification to mitigate economic losses		1.34
7.	Undertaking Integrated Farming System for sustainable farming		2.01
8.	Following drainage system to avoid water logging and soil and water erosion		0.75
9.	Adopting borewell recharge technology to overcome shortage of water for crop production		2.03
10.	Undertaking micro irrigation to overcome shortage of water and prevent water wastage		1.80
11.	Adapted to modern methods of agriculture like usage of planters, tillers, zero tillage etc.		1.65
12.	Performing subsoiling (once in 4-5 years) to improve water infiltration		3.24
13.	Getting adapted to cultivating crops having high water use efficiency like millets, oilseeds and pulses		4.23
14.	Getting adapted to the usage of bio-fertilizers and bio-pesticides		2.75
15.	Using chemical fertilizers and pesticides at recommended levels at right time		1.44
16.	Practicing mulching and inter-cultural operations to avoid weed infestation		1.81
17.	Undertaking crop rotation to improve soil fertility		1.53
18.	Cultivating catch crops, contingent crops and mixed cropping to avoid economic losses due to unforeseen climatic mishaps.		1.71
19.	Following IPM practices including cultural, mechanical, biological and chemical methods		1.91
20.	Planting of trees like Drumsticks, coconut, custard apple, mango etc. on the borders to prevent the fields from winds		1.65
21.	Undertaking suitable post-harvest management practices		1.40
22.	Shifting focus to value addition agriculture		0.95
	Adapting to contingency cropping plans in case of aberrant weather conditions		
	Rainfall abnormality	Action taken	
23.	Delayed onset of rainfall	Sowing alternate crops of short duration or early maturing varieties of same crop	3.44
24.	Early withdrawal of rainfall	Using anti-transpirant sprays, early harvesting at physiological maturity	0.96
25.	Intermediary dry spell	Undertaking mulching, thinning, using anti-transpirants	1.45
26.	Heavy rainfall	Undertaking practices of water harvesting structures, proper drainage channels, using water-logged resistant varieties	3.66
Livestock Production			
27.	Adopting subsidiary activities like animal husbandry, sericulture, apiculture etc. to mitigate any economic losses due to climatic variability		1.50
28.	Rearing heat and stress tolerant breeds of animals		1.33
29.	Growing highly nutritious fodder crops like Napier, Alfalfa to increase strength in animals		1.9
30.	Using feed additives to improve milk quality under heat stress conditions		2.45
31.	Having proper drainage channels to let out water and urine especially in rainy season		0.83
Economic aspects			
32.	Having access to credit to meet financial needs in case of any contingency		4.15
33.	Having timely access to labour in case of an abnormal weather forecast to hasten harvesting or storage of produce		3.66
34.	Having access to market and better transportation systems		0.96
35.	Having access to and receiving MSP of selected crops		1.45
36.	Getting organized in the form of FPOs for collective action		1.5
Communication behaviour			
37.	Having access to formal extension advisory services about multi stress resistant varieties		1.78
38.	Having access to Disaster relief assistance		1.65
39.	Having access to timely and reliable weather forecast information		2.75
Resources available to cope up			
40.	Having sufficiency of farm machinery to meet any kind of contingency		1.90
41.	Having good access to agri-inputs		1.90
42.	Having good livestock productivity to avoid economic losses due to heat stress in animals		0.83
43.	Adopting the usage of renewable sources of energy like solar, wind etc. for power and irrigation		1.96
44.	Having multiplicity of irrigation resources like drip, sprinkler etc.		1.50

45.	Having good availability of proper storage facilities	3.17
Innovative behaviour		
46.	Developing new ways to cope with water stress, heat waves, cold waves or floods	1.50
47.	Using social media to know more about climate change and be ready to adopt measures quickly	0.96
48.	Adoption of new varieties and hybrid seeds instead of last year's seeds (to avoid inbreeding depression)	4.58
49.	Using mobile applications promoted by JAU and ICAR to get updated about climate change and follow recommended practices to cope with it.	1.45
Environment		
50.	Constructing reservoirs or structures to collect water in case of floods to reduce flood losses	0.83
51.	Constructing ponds for groundwater recharging by accumulating rainwater	1.50
52.	Recycling of organic waste/kitchen waste and using it as manure for crops and vegetables	4.54

Reliability: The split-half method was employed to test reliability. The scale was divided into two halves based on odd and even-numbered statements and administered to 30 respondents. The two sets of scores obtained were then analyzed using the Karl Pearson product-moment correlation coefficient to measure the reliability, calculated using the following formula:

$$r_{oe} = \frac{N \sum XY - (\sum X)(\sum Y)}{[N \sum X^2 - (\sum X)^2][N \sum Y^2 - (\sum Y)^2]}$$

Where,

N= Number of respondents

X= Value of odd numbered items score

Y= Value of even numbered items score

The value of correlation coefficient was 0.58 and this was further corrected by using Spearman's Brown formula and obtained the reliability coefficient of whole set. The formula used was:

$$r_{tt} = \frac{2r_{oe}}{1 + r_{oe}}$$

The r value for scale was 0.73, which was significant at one percent level of significance, indicating the high reliability of the instrument. It may be said that, the test is reliable to measure the adaptability of respondents to climate change.

Viii) Final administration: The finally selected statements of the scale were arranged and incorporated in the final format of the interview schedule for the farmers.

Results and Discussion

The scale consisted of 25 statements. Respondents were asked to express their response on a five-point continuum viz. strongly agree, agree, undecided, disagree, and strongly disagree. As all of the statements had a positive connotation, scores of 5, 4, 3, 2 and 1 were given to strongly agree, agree, undecided, disagree, and strongly disagree responses, respectively. The maximum obtainable score by a respondent was 125 and the minimum was 25. Then, on the basis of mean and standard deviation, the respondents were categorized into following three groups shown in Table 3:

Table 3: Categorization of farmer groups

S. No.	Category	Range
1.	Low adaptability to climate change	<Mean-SD
2.	Medium adaptability to climate change	Mean± SD
3.	High adaptability to climate change	>Mean+ SD

The final statements were categorized into 6 sub dimensions viz. crop production, livestock production, economic aspects, communication behaviour, resource available to cope up and innovative behaviour as shown in Figure 1.

The final scale has been shown in the Table 4.

Table 4: Modified statements for final administration (final scale)

S. No.	Statements	Responses				
Crop Production		S	A	U	D	SD
1.	Undertaking the application of FYM and mulching to avoid soil erosion and evaporation losses from the field					
2.	Undertaking growing drought resistant crops and varieties					
3.	Selecting early maturing or late maturing varieties depending upon the weather experience of previous years to escape losses incurred from weather abnormality					
4.	Undertaking Integrated Farming System for sustainable farming					
5.	Adopting borewell and well recharge technology to overcome shortage of water for crop production					
6.	Undertaking micro irrigation to overcome shortage of water and prevent water wastage					
7.	Performing deep ploughing to improve water infiltration					
8.	Cultivating crops having high water use efficiency like millets, oilseeds and pulses					
9.	Using of bio-fertilizers and bio-pesticides					
10.	Practicing inter-cultural operations to avoid weed infestation					
11.	Following IPM practices including cultural, mechanical, biological and chemical methods					
12.	Sowing alternate crops of short duration or early maturing varieties of same crop (due to delayed onset of rainfall)					
13.	Undertaking practices of water harvesting structures, proper drainage channels and using water-logged resistant varieties etc. (due to heavy rainfall)					
Livestock Production						
14.	Growing nutritious fodder crops like maize and alfalfa to increase strength in animals					

15.	Using feed additives to improve milk quality under heat stress conditions				
Economic aspects					
16.	Having access to credit to meet financial needs in case of any contingency				
17.	Having timely access to labour in case of an abnormal weather forecast to hasten harvesting or storage of produce				
Communication behaviour					
18.	Having access to formal extension advisory services about multi stress resistant varieties				
19.	Having access to timely and reliable weather forecast information				
Resources available to cope up					
20.	Having sufficiency of farm machinery to meet any kind of contingency				
21.	Having good access to agri-inputs				
22.	Adopting the usage of renewable sources of energy like solar, wind etc. for power and irrigation				
23.	Having good availability of proper storage facilities				
Innovative behaviour					
24.	Adoption of new varieties and hybrid seeds instead of last year's seeds (to avoid inbreeding depression)				

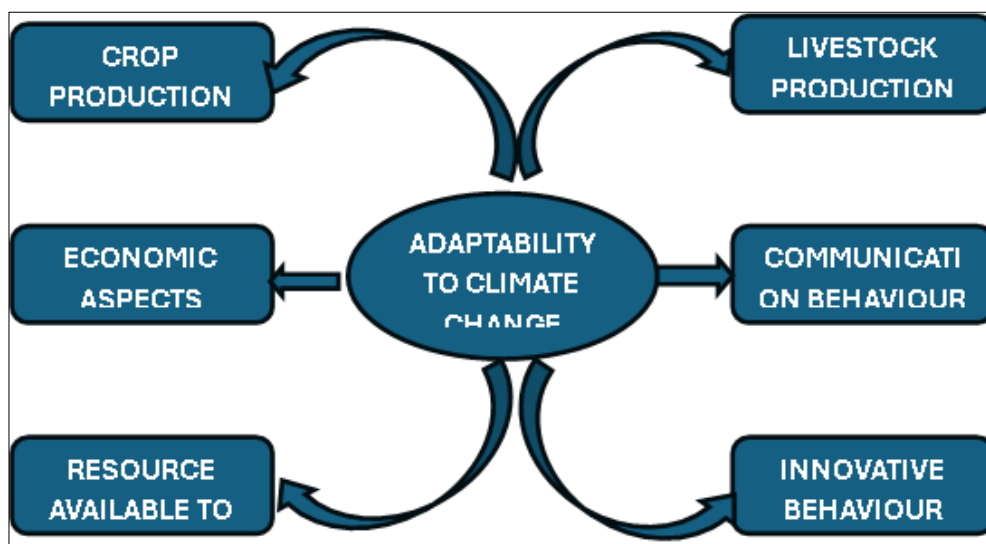


Fig 1: Adaptability and its sub dimensions

Conclusion

Climate change is unequivocally a serious concern. The discussions on the issue have been very frequent on global platforms. Agencies and organizations like United Nations have understood the severity of the problem and initiated many programmes to combat the issue. Climate change is an imminent and intensifying global challenge, particularly in developing countries like India, where agriculture is highly sensitive to shifts in climate patterns. The adaptation of farmers to climate change is crucial for safeguarding agricultural productivity and, by extension, food security. While many farmers perceive climate change as a reality, a comprehensive understanding and adaptive response are still limited by factors such as awareness, adaptability and socio-economic conditions. The construction of a scale to measure farmer adaptability is a significant step towards quantifying this critical aspect. Using the Likert summated ratings method, the scale was developed through rigorous item collection, editing, and validation processes, involving experts from agricultural universities and extension institutes. This scale, comprising carefully selected statements, will help assess the readiness of farmers to adapt to the adverse effects of climate change. Ultimately, it is hoped that this tool will aid in tailoring interventions and policies to strengthen farmers' resilience and ensure sustainable agricultural practices in the face of climate change.

Competing Interests

Authors have declared that no competing interests exist.

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